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BULLETIN 129

December, 1903

Ontario Agricultural College and Experimental Farm.

BACON PRODUCTION.

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PART I.—BUILDINGS.

The question of buildings for swine is such a complicated one that it seems a hopeless task to attempt a discussion of the subject. Almost every piggery that is built possesses certain features peculiar to itself, and rendered necessary by the circumstances which it is intended to meet. All that will be attempted here, therefore, is a brief discussion of the desirable features of a piggery, illustrated by drawings of a cheap and convenient building which may be modified to meet almost any requirements.

The most important requirements of a piggery are dryness, ventilation, light, freedom from draughts, reasonable warmth, and convenience.

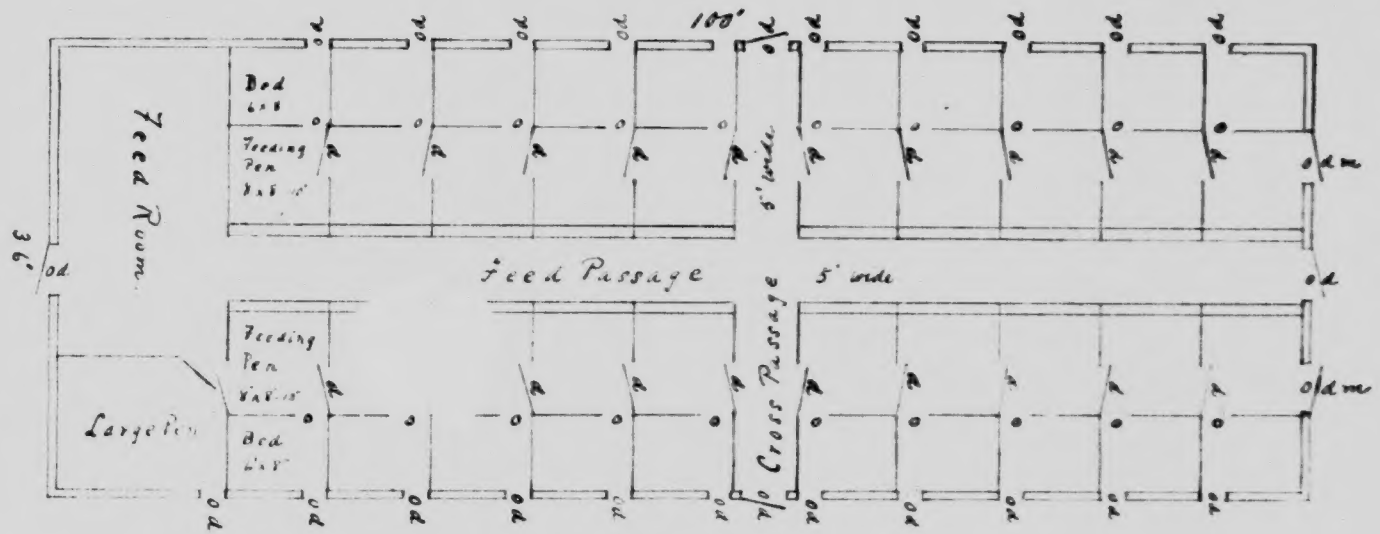
Dryness. Dryness is closely associated with ventilation, but is also influenced by the material of which the building is constructed. Good results can not be obtained in a damp pen; and dripping walls are a pretty sure indication of impending disaster. Rheumatism and numerous forms of unthriftiness result from dampness. Stone and cement walls are very cold in winter, and chill the air of the pen, causing it to deposit its moisture upon their surface. In a short time the wall becomes quite wet, and trouble is stored up for the pigs. A hollow cement wall is much less objectionable than a solid one; but our experience leads us to prefer wooden walls, constructed in such a way as to form a complete dead air space in the centre.

Ventilation. Thorough ventilation is a great help in preserving dryness; but it is a difficult thing to secure in a piggery without unduly lowering the temperature. It is a great aid to ventilation to provide a large air space, or, in other words, to have a high ceiling. The tendency at present is to do away with the common loft over the piggery, and to have the space above the pigs extend to the roof. This gives more air space, and makes ventilation a simpler problem. The admission of fresh air can be provided for by constructing shafts in the walls at intervals of fifteen or twenty feet. These shafts open outside near the ground, and inside, at the ceiling. Provision should be made for the closing, or partial closing, of these intakes when cold air is admitted too rapidly. Windows in the roof, as described in the plan, are a very effective means of removing foul air.

Light. Light, especially sunlight, has a wonderful influence in promoting health. So far as possible, the windows should be on the south side of the building, as the south side gets most sun, and is least exposed to cold winds.

Draughts. While ventilation is necessary, draughts are extremely injurious, and their prevention should be kept in view when building.

Warmth. Warmth is a good thing; but it should not be secured at the expense of ventilation. A somewhat cold pen, well ventilated but free from draughts, is preferable to a warm pen where the air is damp and foul, and the pigs will suffer less discomfort in the former than in the latter.



Plan of Piggery.

Explanations: o. Openings 2½ feet wide between bed and feeding pen.
d. Doors 4 feet wide in partitions, which swing back and close openings at o.
o d. Doors leading outside.
o.d.m. Doors for taking out manure, or taking in bedding.
Pens are uniform size throughout. Dimensions of pens include partitions.

Plan of Piggery.

The plan which is given here is taken from a new piggery built this year by Mr. J. E. Brethour, Burford, Ont. Its construction is comparatively cheap, and its possesses many desirable features. It is capable of many modifications; and a careful study of the plan will be helpful to those who intend to build. Of course, the building can be made any length desired.

The building is 36 x 100 feet, outside measurement. A cement wall 8 inches thick rises 3 feet above the floor. On top of this wall the frame is built. The walls are built of 2 x 4-inch studding, boarded on the outside with cheap lumber, covered with building paper and tightly clap-boarded on top of the paper. On the inside, the walls are lined with matched lumber, so as to form a dead air space inside. The lining also extends over the lower side of the rafters, giving a dead air space to the roof, as well as the walls.

Cross section of Piggery, showing contour of floor, shape of roof, and supports for same.

From the cross-section it will be seen that the total height of the wall on the north side is 11 feet and of that on the south side 8 feet. The roof has the same pitch on both sides, so that there is a drop of 3 feet from one section of the roof to the other, at the centre of the building. In this space windows are inserted to throw light and a certain amount of sunshine into the row of pens along the north side of the building. These windows are hinged at the bottom and can be opened at any angle according to the requirements of ventilation. A ratchet device, similar to that used for opening the ventilators in greenhouses, would be very convenient for this purpose.

The floor is cement. Cement is so durable and so easily cleaned, that it seems to be about the only satisfactory floor. The part A B (see cross-section) is 6 inches higher than C D. There is a fall of 1½ inches from A towards B, and a fall of 3 inches from D towards C. Thus all the drainage is towards C, the lowest point; and the bed, being on top of A B, is always dry.

There is a partition 3½ feet high between the bed and the feeding pen, and the opening from the bed to the feeding pen is 2½ feet wide. The partition shelters from draughts, and also economizes bedding by holding the straw in place. The other partitions are 4 feet high. The partition next to the feed passage is made of No. 9 coil steel wires, 2 inches apart at the bottom and grading to about 3 inches apart near the top. They are stiffened by a

heavy upright wire in front of each pen, fastened to the horizontal wires by means of washers used for that purpose. The wire partition is set in about 2½ inches from the side of the trough next to the passage, thus allowing room to pour feed into the troughs.

The troughs are cement, and are 8 inches high next to the feed passage, 4 inches high next to the feeding pen, and 10 inches wide.

The feed passage, which is 5 feet wide, is 4 inches lower than the feeding pen. This is merely a device to show the pigs to better advantage.

The purpose of the doors in the partitions between the pens is easily understood. They can be swung back, closing the pig in the back apartment and leaving a continuous passage for cleaning out the pens. The bedding is also taken in and distributed from this passage. These doors are also used in moving pigs from one pen to another, since there are no doors from the pens into the feed passage. The absence of doors from the pens into the feed passage is one of the most inconvenient features of the pen, but is hard to avoid where a wire partition is used. The wire partition, however, is more sanitary than wood and gives a much better view of the pigs.

It will be noticed that the sleeping quarters have cement floors. When bedding is plentiful this may give no trouble, but it would be a simple matter to place a portable wooden platform on the cement.

The roof is supported by the four lines of posts to which the partitions are fastened. Each row carries a line of plates which support the rafters.

There are six windows, each 5 feet long by 2½ feet high, in the south wall, and the same number in the roof, placed as previously described. The north wall has only two windows.

The dimensions given for the small pens, include partitions.

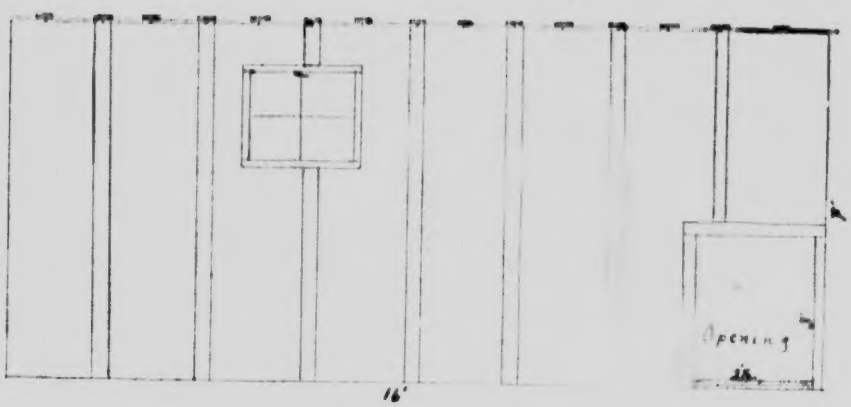
The pens as described are not suitable for farrowing pens. As a matter of fact, it is better to have sows farrow in a building away from other pigs, especially during cold weather when the building must be kept pretty well closed up. The air of a piggery where a large number of pigs are kept, does not seem to agree well with little pigs. However, if it were desired to have the sows farrow in the large piggery, one of the sections on the south side could be modified to answer the purpose by making the sleeping apartments 2½ feet wide, thus giving beds 8 x 8½ feet.

The absence of a loft for storing straw will be a strong objection in the eyes of many. The ventilation of the building, however, and the health of the animals are of vastly greater importance than the inconvenience occasioned by the absence of a loft. It is generally possible to locate the building so as to make it comparatively easy to obtain straw for bedding.

Portable Pens.

The accompanying sketches show a very cheap and easily constructed pen, suitable for winter quarters for breeding sows. The pen is 16 feet long by 8 feet wide. It is 7 feet high in front and 3½ feet high at the rear. It is boarded with cheap lumber, but all cracks are securely battened. It should be practically wind and rain proof. The opening is at one corner; and the pen should be set with the opening towards the south. A door is not necessary. Plenty of bedding should be supplied, and the pen should be banked outside with horse manure to the depth of about two feet. This method of housing sows is better than close confinement in warm pens. The same pens will answer for shelter from the sun in summer.

End view of Portable Pen



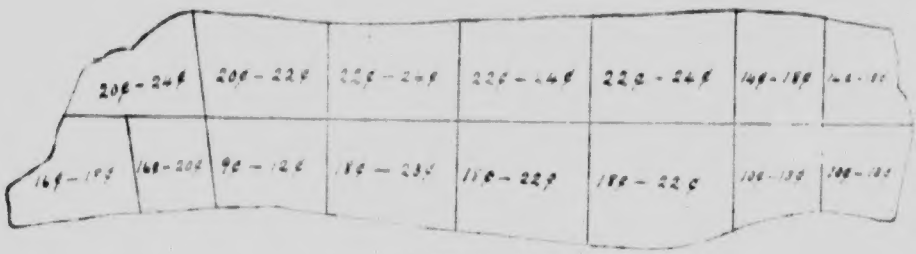
Front view of Portable Pen

PART II.—THE CANADIAN EXPORT TRADE.

In the United States there is an immense home market for lard and oleomargarine (artificial butter). In Canada we have no trade in oleomargarine and a very much smaller home market for lard. The American packer, therefore, can utilize very fat hogs, manufacturing lard and oleomargarine from the fat and placing only the leaner carcases and the lean parts of the fat carcases upon the market to be consumed as meat. On the other hand, practically all the Canadian hogs must be consumed as meat; and as there is a very limited and decreasing demand for fat pork the production of a leaner class of hog has become a necessity in Canada. Great Britain is the home of the export trade in pork products of both Canada and the United States, the latter country exporting vastly larger quantities than Canada; and to keep out of a hopeless competition with the Americans our packers have been forced to cater to an entirely different class of customers. Thus it comes that the lean and carefully prepared bacon of Canada is taken by the large cities and retailed to the well-to-do classes, while the American product goes mainly to a less fastidious class of customers at a lower price. Canadian bacon, therefore, does not come into direct competition with the bulk of the American product in Great Britain; and a very little consideration of facts outlined above should convince any thoughtful person of the importance of avoiding American competition as far as possible. As a matter of fact, we are compelled to go out of the fat hog business, owing to the vast advantages possessed by the Americans in the way of markets for their products.

The kind of bacon of which Canadian packers make a specialty is what is known as the "Wiltshire side." Denmark and Ireland are our main competitors; but their conditions are somewhat similar to our own, and the competition, therefore, is not a hopeless one. At the same time, we need to put forth every effort if we are to hold our own in the British market; and hence we require to give the subject of bacon production most careful study.

To make Wiltshire sides, a hog is required weighing from 160 to 220 pounds live weight. These are not cast-iron limits, though 160 pounds is rather too light for making the best side. The most suitable weights are from 180 to 190 pounds. The diagram which follows shows a retail dealer's method of cutting a Wiltshire side and the approximate retail values in Great Britain.



A Wiltshire Side,
Showing retail dealer's method of cutting, and approximate range of retail values in Great Britain.

The diagram shows that the most valuable meat is found along the upper part of the side as far forward as the shoulder. When the shoulder and neck are reached there is a very material drop in the value. This teaches that the hog with a heavy, rough shoulder produces a very undesirable side, because it gives a side which is heavy at the cheap end. It teaches further that the hog should have good length from the back of the shoulder to the ham, because this is the most valuable part of the side of bacon. It will be noted

Fig. 1. No. 1 selection.¶

Fig. 2. Fat.

also that the belly meat is cheaper than the part above it, and this explains why we require the bacon hog to have a trim belly and a straight underline.

The figures given on page 7 are from photographs of sides from hogs used our breed experiments.

Fig. 1 shows a No. 1 side. Note the uniformity in thickness of the layer of fat along the back. This layer of fat should be from 1¼ to 1½ inches in thickness, and should be practically the same thickness from loin to neck. The side is very uniform in depth also, and does not show undue weight on shoulder and neck. Compare this with Fig. 2, which represents a fat side. There is too much fat all along the back, and the fat arches considerably over the shoulder. If these two sides are compared with the diagram, it will be seen at a glance how much more cheap meat is shown in Fig. 2 than in Fig. 1. The side shown in Fig. 2 came from a hog possessing a heavy, arching neck, a broad shoulder, broad, fat back, and a deep, heavy belly.

The conformation required for bacon production is described more fully under selection of boar and sow.

PART III.—BREEDING FOR BACON.

To produce the best type of hog for bacon production, care must be taken in the selection of breeding stock. There are those who claim that it is practically all a matter of feeding; but this is a very serious mistake. It is true that by careful feeding an objectionable type of hog can be greatly improved, but it can never be made to produce an ideal side of bacon. To produce the best bacon, both the breeding and the feeding must receive careful attention.

Breeds of Swine.

In 1896 an experiment was commenced for the purpose of comparing six breeds of swine, both as regards economy of gain and suitability for the export trade. The breeds used were Berkshire, Yorkshire, Tamworth, Chester White, Poland China, and Duroc Jersey. The experiment was repeated in 1897, 1898, 1899, and 1900, making five carefully conducted tests. In each of the five years, six pigs of each breed were used for the test. In 1901 the same breeds were again fed under the same conditions, using a larger number of each breed. This experiment, however, was conducted for the purpose of comparing outside with inside feeding, and no attempt was made to compare the relative cost of production in the different breeds. The breeds were compared however as to suitability for export.

Altogether, therefore, we had five experiments in which the six breeds were compared as to cost of producing 100 pounds gain, live weight; and six experiments in which the six breeds were compared as to their suitability for export.

The Relation of Breed to Economy of Production.

The table given below shows the average amount of meal required for 100 pounds gain, live weight, in the five experiments. In the making up of this table only the meal has been considered. Such foods as dairy by-products and green feed, which were fed sometimes, were the same for all breeds, and have been omitted to simplify the comparison.

The following shows the average amount of meal consumed for 100 pounds gain, live weight, in five experiments:

	Pounds.		Pounds.
Berkshire	364.45	Duroc Jersey	384.23
Yorkshire	369.51	Chester White	387.89
Tamworth	380.47	Poland China	391.42

Before any conclusions are drawn from the table given above, a second table will be presented for consideration in connection with it. This table shows the standing of the breeds for each year, each column being ranked in order of economy of gain:

Table showing the different breeds ranked in order of economy of gain for each year of the experiment:

1896.	1897.	1898.	1899.	1900.
Berkshire.	Berkshire.	Yorkshire.	Berkshire	Berkshire.
Tamworth.	Tamworth	Berkshire.	Tamworth.	Yorkshire.
Poland China.	Poland China.	Duroc Jersey.	Yorkshire.	Duroc Jersey.
Duroc Jersey.	Chester White.	Tamworth.	Chester White.	Chester White.
Chester White.	Yorkshire.	Chester White.	Duroc Jersey.	Tamworth.
Yorkshire.	Duroc Jersey.	Poland China.	Poland China.	Poland China.

In considering these tables we must bear in mind that averages are frequently misleading. For example, in a certain experiment one breed may suffer from some unfavorable circumstance which is in no way related to, or influenced by the breeding of the animals; yet this circumstance may seriously affect the average standing of the breed in question.

A study of the last table reveals the fact that there is little or no constancy in the standing of any one breed, except the Berkshires, which certainly make a remarkably good showing. It may be possible that the Berkshires were able to digest and assimilate a larger percentage of their food than were the other breeds, but we believe that, at least, a large share of their success was due to another cause. All the pigs used in these experiments were purchased at ages varying from six to ten weeks, and it was noted that the Berkshires seemed to adapt themselves to the new conditions and change of food more readily than any of the other breeds, and thus scored an advantage at the commencement of the experiment, which they generally held until the close. We are inclined, therefore, to attribute their high standing to their ability to adapt themselves to changed conditions, rather than to their power to digest and assimilate a larger percentage of their food.

Everything considered, we are led to the belief that there is little, if any, relation between breed and power to digest and assimilate food, and that individuality is the all-important factor in this connection. To produce bacon cheaply we require a healthy, thrifty, growthy pig. Whether its color is red, white or black; or whether its ears are erect or drooped, are largely matters of taste.

Relation of Breed to the Export Trade.

It has already been stated that we had six experiments, in which six breeds of swine were compared as to their suitability for producing export bacon. In each experiment the hogs were shipped to the Wm. Davies Co., Toronto, where they were slaughtered and the carcases critically examined by an expert, who was given no information as to the breeds which they represented. The table given below shows the different breeds ranked according to suitability for the production of "Wiltshire sides."

1896.	1897.	1898.
1. Yorkshire, Tamworth.	1. Yorkshire.	1. Yorkshire, Tamworth.
3. Berkshire.	2. Tamworth.	3. Berkshire.
4. Duroc Jersey, Poland China, Chester White.	3. Berkshire, Chester White, Duroc Jersey, Poland China.	4. Poland China.
		5. Chester White, Duroc Jersey.

1899.	1900.	1901.
1. Yorkshire.	1. Yorkshire.	1. Yorkshire.
2. Tamworth.	2. Berkshire.	2. Tamworth.
3. Berkshire.	3. Chester White.	3. Berkshire.
4. Chester White, Duroc Jersey, Poland China.	4. Tamworth.	4. Duroc Jersey.
	5. Duroc Jersey.	5. Poland China.
	6. Poland China.	6. Chester White.

From this table is will be seen that the Yorkshires had a very distinct advantage in this part of the experiment. The Yorkshire carcases were characterized by good length of side, uniformity in thickness of fat along the back, a good general development of flesh (lean), thickly fleshed loin, thick, fleshy belly, and a fleshy ham which required little trimming. Their most serious faults ran in the direction of an undue weight of shoulder, coarseness of bone and thickness of skin, though these defects were noticeable in only a small proportion of the carcases.

The Tamworths generally had a light shoulder and a very uniform layer of fat along the back; but, as a rule, they did not quite equal the Yorkshire in length of side, thickness of loin and belly, and development of ham. In many of them there was a marked lack of flesh over the loin, accompanied by a thinness of belly and a decided lightness of ham.

The strong point of the Berkshire carcases was their large muscular development, giving a fleshy carcase. The ham was well developed; but, in many cases, it carried too much fat and required considerable trimming. The main faults were the shortness of side and an undue weight of shoulder, with the fat running very thick over the shoulder top. There was, moreover, a marked lack of uniformity in the Berkshire carcases, some of them making capital Wiltshire sides, while others were entirely unsuitable. The Yorkshire carcases, on the other hand, were specially noted for their uniformity.

The Chester White, Poland China and Duroc Jersey carcases were very similar in character. Occasionally a good Wiltshire side was found among them; but it was a noteworthy exception. Shortness of side, a superabundance of fat, and a lack of flesh were generally characteristic of the group.

Relation Between Bacon Type and Economy of Production.

The results of our experiments are in direct opposition to the theory that it costs more to produce a pound of gain in a hog of the bacon type, than in one of a thick, fat type. It is true that the Berkshire made a better showing in regard to economy of gain than the Yorkshires and Tamworths, which scored highest in the slaughter test; but it is also true that the Berkshires were much superior as bacon hogs to the Duroc Jerseys, Poland Chinas and Chester Whites, and stood higher in point of economy of gain. The last three breeds were the least suitable for export; and they also stood at the bottom of the list in point of economy of gain. If the tables given above prove nothing else, they certainly demonstrate very clearly that a hog of good bacon type can be fed just as cheaply as one of an undesirable type. This also applies to animals of the same breed, but of different types.

Selection of the Boar.

It is perhaps unnecessary to say that the boar should be pure bred. The pure-bred male will transmit his own qualities to his progeny and produce pigs more uniform in character than will a grade or a cross-bred. Not only should he be pure-bred but he should be well-bred; that is to say, he should belong to a family noted for its general excellence in the qualities which we desire to reproduce. In addition to these things he should himself possess those qualities which we wish to see in his progeny. A boar of this description is likely to give satisfactory results.

Bacon Type in Boars.

In the first place a boar should show male character and give indications of strong constitution. He should have good width between the fore legs and be thick through the heart, or just back of the elbow. He should be

deep from the top to bottom back of the shoulder; and the space back of the shoulder should be well filled out, giving a good heart girth. The jowl should be broad and strong, but not fat and flabby; the forehead broad, and the poll broad and full. The neck should be of medium length and strongly muscled, but should show no heavy crown of fat. The eye should be large, full and bright, and his general appearance should indicate alertness and activity.

The shoulders are heavier than would be desirable in a sow or barrow; and as he grows older "shields" develop on the sides, which often give the appearance of roughness. He should be very compact on top, however, and blend well with the top line and the rib at this point. The bacon type shoulder is upright, making the animal comparatively short from the back of the shoulder to the head, and long from the back of the shoulder to the ham. This formation gives the largest development where the meat is most valuable.

The spring of rib is very characteristic. It should arch out boldly from the backbone, then suddenly drop in an almost vertical direction, giving a flat, straight side. This point should receive special attention in making a selection, for it is a sure indication of a strong development of muscle along the back; and muscle is lean meat.

The top line should rise slightly above the straight line, giving a very slight arch, the highest point of which is over the loin. The back should be of medium width and uniform in width throughout. The loin should be as wide as the rest of the back and be full, strong and heavily muscled. The rump should be the same width as the back and loin, slightly rounded from side to side over the top, and from the hips to the tail. The ham should taper towards the hock and carry the flesh well down towards the hock, especially on the inside of the shank.

The underline should be trim and straight, showing no tendency towards a sagging belly; and the hind flanks should be full, giving good thickness through at this point.

The legs should be of medium length, and the bone heavy, but clean and presenting a flattish appearance. Rough, puffy legs are very undesirable; and it is also a serious objection to have the bone fine. The pasterns should be upright, so that the animal walks well up on his toes. A hog with weak pasterns should not be bred from.

The hair should be abundant, but not coarse. A row of bristles standing up along the neck and over the shoulder top is extremely objectionable.

The carriage should be easy, the animal walking without apparent exertion, and without a swaying movement.

Selection of the Sow.

For the production of bacon it is not absolutely essential that the sow be pure bred. A grade sow of good type will usually produce very good pigs for bacon purposes, provided the boar is such as has been described in regard to breeding and quality. Many feeders prefer a cross between two distinct breeds; and, no doubt, this method has produced many excellent pigs. What is the best cross will probably never be known, as it is largely a question of the individuality of the animals used. We have crossed the Yorkshire and Tamworth with the Berkshire and Chester White with very good results; and we have also crossed the Yorkshire with the Tamworth with very fair success. As yet, however, we have conducted no systematic experiments in cross-breeding.

A sow should be selected from a prolific mother, because fecundity is hereditary. The number and development of the teats should also be noted, and at least eleven fully developed teats should be insisted upon. The te-

should be set well apart, and the front teats should be well forward on the body.

Bacon Type in Sows. The sow is finer in head, neck, shoulder, and bone than the boar. Outside of these points, the description given of the boar will also apply to the sow. Extremes should be avoided. A long, scrawny neck, narrow chest, and long coarse legs, indicate a slow feeder and an undesirable quality of bacon. The carcase of such an animal contains too much bone, and is deficient in muscle, or lean meat. The thick, short type is also undesirable; and the best bacon type is a mean between two extremes. Though coarse bone is bad, it will not do to go to the other extreme and select very fine bone. The bone should be clean and strong; and there should be enough of it to insure a good-sized animal. Weak bone, which tends to break down at the pasterns, should not be tolerated.

PART IV.—FEEDING FOR BACON.

Soft Bacon. If we are to maintain and develop our trade in bacon with Great Britain, it is of the greatest importance that we pay strict attention to quality. Not only must our hogs be bred to give the desired conformation, but they must be fed and managed in such a way as to give the desired quality. One of the greatest defects in quality with which our packers have to contend, is a tendency of some sides to turn soft during the process of curing. Softness has nothing to do with fatness; in fact, a thin side is more apt to develop softness than a fat one. In a soft side, the fat is soft and spongy; and sometimes even the lean is affected. There are all degrees of softness up to a mere slight tenderness; but any degree of tenderness detracts very much from the value of a side; and a really soft side is practically worthless. The percentage of soft sides is sometimes very high, even as high as 40 per cent. of the total at certain seasons of the year. It will, therefore, be easily understood that such a condition represents an enormous shrinkage in value; and this loss is bound to be reflected in the prices paid the farmer for his hogs, to say nothing of the injury to the reputation of our bacon in Great Britain. This is not a matter, therefore, which affects merely the packer. It affects the bacon industry as a whole; and the farmer, sooner or later, must shoulder the loss. It is important, therefore, that the farmer should pay particular attention to the question of quality.

Causes of Soft Bacon.

To describe all our experiments under this head would occupy too much space, and would be found tiresome, and perhaps confusing, to the average reader. The conclusions which follow are based upon a careful analysis of our work to date, descriptions of which have been published from year to year in the annual report of the college. We have also been able to draw upon considerable unpublished data.

Exclusive Meal Feeding. This is perhaps one of the most common causes of softness, especially when hogs are confined in pens from birth to the time of marketing. Some kinds of meal are more dangerous than others; but wherever exclusive meal feeding is practised, and the exercise is limited, more or less softness is almost sure to result.

Corn and Beans. Of the grains in common use, corn has the greatest tendency to cause softness. Its injurious tendency can be modified by mixing it largely with other meal, and by feeding skim milk, green foods, and roots; but its tendency to produce softness is so strong that it must be regarded as an undesirable food.

We have not experimented with beans; but the Central Experimental Farm at Ottawa found that beans have an effect similar to corn.

Lack of exercise. Lack of exercise has a tendency to produce softness; but this tendency can be largely overcome by judicious feeding.

Unthriftiness. Unthrifty hogs, no matter what the cause may be, invariably produce soft bacon.

Lack of finish. Thin hogs have a marked tendency towards softness. Marketing hogs before they are properly finished, is no doubt responsible for a good deal of softness.

Holding back. When a hog is finished, it should be marketed at once in order to produce firm bacon. If the feed is cut down, so that the hog makes no gain in weight for some time, or loses in weight, the bacon from such a hog is almost sure to be soft.

Production of Firm Bacon.

From what has been said, it will be seen that softness may result from a number of causes; and it is possible that there are causes outside of those mentioned. Enough has been said, however, to place the feeder on his guard against the most common causes; and below are offered a few suggestions regarding methods of feeding, and management which we have found to give good results.

Feeding. As already stated, exclusive meal feeding is apt to injure the quality of bacon. We have also found that it does not give so economical gains as a mixed diet. Among the foods which we have used along with meal, are skim-milk, whey, roots, rape, vetches, and clover. We have found that these foods, combined with a liberal meal ration, invariably give better gains than an exclusively meal ration, and produce a better quality of bacon. It is probable that much of the beneficial influence of these foods is due to the fact that they help to keep the animals healthy and thrifty, a condition necessary to the production of the best quality of bacon.

But while these succulent foods have an important place in hog feeding, they may also be abused. If an attempt is made to feed hogs almost exclusively upon them, the chances are that the hogs will not be properly finished, and soft bacon will likely result. The use of various foods will be found more fully discussed under "Notes on Foodstuffs."

Exercise. In our experiments, we have found that unlimited exercise during the fattening period is not conducive to cheap production. At the same time, the exercise has a good effect upon the firmness of the bacon produced. We have secured our cheapest gains, and an excellent quality of bacon from allowing the hogs only a limited amount of exercise in small outside yards adjacent to the pens, and feeding a limited ration of mixed meal accompanied with all the green food they will eat. By a limited meal ration, is meant an allowance slightly less than the hogs will eat if given the opportunity. We have found this method more economical than feeding meal on pasture, though it requires more labor. It is a notable fact, however, that hogs which have run at large until they weigh 100 pounds in thin condition, may be finished on almost any meal mixture and still produce firm bacon. This fact illustrates the marked influence of exercise upon firmness of bacon.

Notes on Foodstuffs.

It will invariably be found that a mixture of foods gives better results than a single kind. In the notes which follow, some of the principal pig foods are briefly discussed, and suggestions given regarding their combination with other foods.

Peas. Whole peas are very palatable, but entirely too wasteful, as the hogs do not digest them thoroughly. Pea meal is a valuable food, but should never be fed alone. The heavy, close nature of the meal renders it difficult to digest, and the pigs are very apt to sicken. It combines well with barley, or barley and wheat middlings. A few well ground oats may also be added. Peas are noted for the excellent quality of bacon wihch they produce.

Barley. This is a noted hog food in Europe; but some feeders in this country do not look upon it with favor. We have secured excellent results from barley, however, both in the amount of gain and the quality of bacon. For young pigs it should be mixed with wheat middlings, a very little barley being used at first, and the quantity gradually increased. For older pigs, peas or wheat may be added. Some succulent food, such as roots or green food, should always be fed with it; and skim-milk makes a great improvement. It is not generally regarded with favor as a food for breeding sows.

Wheat. This grain has a higher feeding value than barley, but requires mixing with other meal to get the best results. It combines very well with barley, or barley and middlings.

Oats. Owing to the amount of fibre in this food, hogs cannot digest it so well as can cattle. Oats are more suitable for matured breeding stock than for young or fattening pigs, though a few finely ground oats may be used in a mixture to give variety, and to lighten heavier meal, such as that from peas, wheat, or corn For young pigs, they are better to have the coarser hulls sifted out.

Rye. Rye has a feeding value a little lower than wheat, and a little higher than barley. It may be used in practically the same way as wheat.

Corn. This is a fattening food, and is not conducive to the development of bone and muscle. When fed alone, it gives poor results in producing gain in weight; and its bad influence upon the quality of bacon has already been described. If fed at all, it should be mixed largely with barley or middlings, or both; and some form of succulent food or skim-milk should always be fed with it. Owing to its tendency to produce soft bacon, it should be used as little as possible for hog feeding, when bacon production is the object.

Middlings. This by-product is also called shorts, though some millers make a distinction between shorts and middlings. It is almost universally used for young pigs, and mixed with skim-milk when such is available. If very floury, it is safer to mix a little bran with it, or some finely ground oats with the coarser hulls sifted out, when used for very young pigs; otherwise it sometimes causes indigestion. Soaking for a few hours, or scalding, improves it for young pigs. It combines well with almost any kind of meal, and makes a good food for pigs of all ages.

Bran. The use of bran in pig feeding is rather limited. It contains too much fibre, and is rather too bulky to be fed in large quantity to pigs. Sometimes a little of it can be used to advantage for the purpose of diluting or lightening other foods, as has been indicated. It can be used in larger quantity for matured breeding stock, where the object is to hold the animals in light breeding condition.

Skim-milk. With the exception of whole milk, there is perhaps no food better suited to pigs of all ages than skim-milk. It is especially beneficial in the case of young pigs, and tends to promote the development of bone and muscle. For fattening purposes, milk has been found to have the greatest feeding value per 100 pounds, when not more than three pounds of milk are fed for each pound of meal. Fed in this way, as low as 327 pounds of skim-milk have proved equal to 100 pounds of meal. This is an exceptionally good showing, however. In Danish experiments, it required, on an average, about 600 pounds of milk to equal 100 pounds of meal; but in these cases a very much larger proportion of milk to meal was used than the proportion mentioned above. In feeding skim-milk, therefore, the feeder must take into account the relative cost of milk and meal, in deciding what proportions to feed.

A strong point in favor of skim-milk, is the excellent quality of bacon it produces. It tends to correct the evil influences of corn, when fed in conjunction with that food; and our experience is that when it is used, hogs produce firm bacon though kept in comparatively close confinement.

Whey. Though unsuitable for very young pigs, a limited amount of whey gives very good results after the pigs are three or four months old. We have obtained the best results from whey feeding by using only enough whey to make the meal into a thick slop. When fed in this way, we have found that it requires from 12 to 14 pounds of whey to be equal in feeding value to one

pound of meal. This is a very much higher feeding value for whey, however, than can be expected when it is fed in large quantity.

Its influence upon the firmness of bacon was very satisfactory; and it appeared to correct the bad influence of lack of exercise.

Sugar Beets. Hogs seem to prefer sugar beets to almost any other kind of roots. Some difference of opinion exists regarding the amount of roots that may be fed with profit to hogs. They should be fed in limited quantity to small pigs; but pigs weighing over 100 pounds live weight, will, in some cases, take five or six times as much roots as meal, by weight, and make very good gains. We have obtained our best results, however, from feeding equal parts by weight of roots and meal. The proportion of roots may be increased considerably, if thought advisable, as the hogs advance in weight.

In all our experiments, we have obtained very satisfactory results from root feeding, so far as firmness of bacon is concerned.

Mangels. Though not quite so high in feeding value, mangels compare very favorably with sugar beets for hog feeding. If the hogs have not been fed sugar beets, they will eat mangels very readily. Their influence upon the firmness of bacon is the same as that of sugar beets.

Turnips. Hogs are not so fond of turnips as of mangels and sugar beets; but if they do not know the taste of either mangels or sugar beets, they will eat a considerable quantity of turnips. Turnips are made more palatable by cooking, though it is doubtful whether cooking increases their actual feeding value, which is very similar to that of mangels. We have found the feeding of turnips along with a meal ration to give a firmer quality of bacon than when meal is fed alone.

Potatoes. Cooking is essential in order to get the best results from potatoes. If they can be cooked so as to leave them dry and mealy, hogs will eat them much more readily. They make a very palatable food when mashed and mixed with meal. Their influence upon the quality of bacon is also beneficial.

Artichokes. In some sections, this crop is very popular as a hog food. It is suitable, however, only for somewhat light, sandy soils. Artichokes may be planted in the late fall or early spring, in rows 21 to 24 inches apart, and from 12 to 18 inches apart in the rows. They are usually ready to feed about September 15th, and the hogs are turned in to dig them for themselves. Frost does not injure them, and usually enough are left in the ground for another crop, if it is thought advisable to leave them. When it is desired to eradicate them, the hogs may be turned on them again in the spring, and the plot subsequently sown with turnips.

Artichokes have a little higher feeding value than potatoes, and hogs are very fond of them.

Feeding Value of Roots. As has already been intimated, much of the feeding value of roots consists in their action upon the general health of the animal. They tend to prevent indigestion and constipation, and to promote general thrift. The results of our experiments, and of those conducted by other experiment stations, indicate that from 6 to 8 pounds of sugar beets, mangels, or turnips, are equivalent in feeding value to one pound of mixed meal; and that 4 to 4½ pounds of potatoes are equivalent to one pound of mixed meal. The meal equivalent of roots varies considerably, depending upon circumstances; but the figures given will serve as a general guide.

Rape. This is an exceptionally valuable food for swine, and may be pastured, or cut and fed to the pigs in pens. For fattening hogs, we have obtained best results from feeding about a two-thirds meal ration, and all the rape the hogs will eat. The hogs were kept in pens with small outside yards, and the

rape was cut and carried to them. This method of feeding gave more economical gains than fattening on pasture, and the bacon was of equally good quality.

For breeding sows, however, pasturing the rape is preferable, owing to the exercise it gives the animals. When on rape pasture, matured sows require little other food.

Young, growing sows, however, require a fairly liberal meal ration in addition to the rape.

Vetches. Hogs eat vetches even more readily than rape, but the vetches do not furnish so much food per acre. The vetches are ready for pasture a little earlier than the rape, and our common practice is to sow half our hog pasture with vetches, and half with rape. The sows are turned on the vetches first; and after this is eaten off, they are turned on the rape, and the vetch ground is sown with rape to furnish pasture late in the season.

Vetches may also be used as a soiling crop, as described under rape.

Hairy Vetch. The seed of this crop is very expensive. There is no doubt, however, that it makes an excellent pasture crop for swine. If not pastured too closely, it grows up quickly when the hogs are removed. For early spring pasture, it should be sown early in the fall, the latter part of August being a suitable time in most seasons. About 1½ bushels of seed per acre are required.

It is our intention to modify our arrangements regarding our hog pasture, and to sow about one-third of it with hairy vetch and rye in the fall; and in the spring, sow one-third with common vetches, and one-third with rape. The hogs will then go on the rye and hairy vetches early in the spring, then on the common vetches, and then on the rape. The common vetch ground will be sown with rape as soon as the hogs leave it; and the hairy vetches and rye will make a second growth while the hogs are eating the first plot of rape. By this means we hope to provide pasture earlier in the season than our present plan permits.

Red Clover. This crop is best suited for pasture; and the hogs should be given quite a large range, or the clover will likely be killed out. It is especially useful for breeding sows.

Alfalfa. Where the soil and other conditions are suitable, alfalfa makes an almost ideal pasture for swine. Care must be taken, however, not to pasture too closely, or the crop may be destroyed. On the college farm, where a short rotation is practised and only a small plot is set apart for a hog pasture, we think we get more satisfactory results from annual crops.

Soja Bean. This crop makes a valuable soiling crop for swine, but is not suitable for pasture. It has a high feeding value, and is much relished by swine. The crop is usually sown at the rate of half a bushel per acre in drills two feet apart. The medium green variety is quite satisfactory for this purpose. It is usually sown in the early part of May.

Feeding and Management of the Boar.

The age at which a young boar may be first used, depends a great deal upon his development. Some boars will serve a few young sows when only six or seven months old, and apparently not be injured by it. As a rule, it is safer not to use a boar before he is eight months old, and to use him as sparingly as possible until he is a year old. No hard and fast rule can be laid down, and the owner must exercise his judgment in the matter.

The quarters for the boar should be roomy, and he should have an outdoor lot in which to take exercise. Some boars are extremely active, and will take plenty of exercise in a comparatively limited space. Some are very

quiet and inclined to become too fat It will be found beneficial with such a boar to force him to gather part of his living from pasture.

The boar should not be permitted to serve a sow more than once, and under no circumstances should he be allowed to run with the sows to which he is to be bred. This practice exhausts the boar, and is likely to result in small, weak litters. The best plan is to turn the sow into the boar's pen when she comes in heat, and to remove her immediately after she is served.

Boars frequently become lousy from serving lousy sows. Almost any of the standard sheep dips will kill lice if faithfully used. They should be mixed somewhat stronger than the directions call for. Coal oil is a very effective insecticide; but its tendency to blister the skin renders it objectionable. An excellent wash may be made as follows: Thoroughly mix 4 oz. of soft soap with 6 quarts of soft water; then add 8 oz. of naptha and mix again. This wash makes a good insecticide, and is also beneficial to the skin. The remarks on remedies for lice apply to all classes of pigs.

The food for the boar should be varied, nutritious, and [illegible] Succulent foods, such as roots in winter, and green food of [illegible] summer, should always be fed with his meal ration. Succulent [illegible] necessary to keep him in good health. Finely ground oats are [illegible] for the main part of his meal ration. An equal weight of middlings and bran, added to the oats, makes a good combination. Small portions of other kinds of meal may be added, if desired. He should have only what he will eat up clean; and if he is inclined to become fat the food should be reduced.

Feeding and Management of the Sow.

A sow should not be bred before she is eight months old, and in many cases it is better to delay breeding two or three months longer. The development of the sow will influence the breeder in this matter.

During the period of gestation, sows of all ages should have abundant exercise. In summer, pasture should be provided for them. The winter quarters may vary with conditions; but the matter of exercise should not be neglected. Where only a few sows are kept, they can frequently be given the run of the barnyard, where they will take exercise rooting over the manure. They should have dry, well bedded sleeping quarters, that are free from draughts. When it is impossible to use the barnyard, it is more troublesome. Perhaps one of the best methods is to make use of the exercising stable described in another place. These should be placed at least [illegible] yards the feeding troughs. The door should face the south, and the pen should be kept well bedded. If the pen is banked [illegible] out the outside with horse manure, draughts will be excluded, and the pen will be comfortable and well ventilated. This plan forces the sows to take exercise in going to and from the troughs, and exercise is absolutely essential to the production of strong, healthy litters. A large number of sows can be run together in this way. Care should be taken to provide plenty of trough room; and the troughs should be located on high, dry ground, or a platform should be arranged on which to place them.

A record should be kept of the date of service of each sow, so that the date of farrowing will be known in advance. Sixteen weeks from date of service to date of farrowing, is a sufficiently close calculation. A week or ten days before she farrows, the sow should be placed in the farrowing pen, so as to become accustomed to her changed conditions before farrowing. She should still be encouraged to take a reasonable amount of exercise, however.

The pen should be provided with guard rails, made of 2 x 8-inch planks placed with the edges against the sides of the pen about ten inches from the floor. These prevent the sow from lying against the partition and lessen the

danger of injury to the little pigs, which often find the space under the guard rail a very convenient refuge. A little cut straw or chaff makes the best bedding, as the little pigs are apt to become entangled in long straw, and find difficulty in keeping out of the way of the sow when she moves about. The sow should be handled, more or less, before she farrows, so that she may become accustomed to the presence of the attendant in the pen. A sow treated in this way, is less likely to become irritable and excited when the attendant enters the pen after she farrows. If everything goes well, she will require but little attention after farrowing, and the less she is interfered with, the better, except when it is absolutely necessary.

Many sows will take the boar a few days after farrowing. To breed a sow at such a time is a bad practice. No sow can do justice to herself and two litters of pigs at the same time. The sow usually comes in heat a few days after her pigs are weaned, and may then be bred again, if not too much pulled down by nursing. If she has raised a large litter and is very much emaciated, the chances are that she will produce a very small litter the next time, if she is bred immediately after her pigs are weaned. In such instances, she should be given three weeks or a month of liberal feeding to enable her to regain her lost strength and vitality before she is bred. Many a man has been puzzled to know why his sow, which had raised a fine, large litter, should drop down to only four or five puny pigs the next time. The reason is not far to seek. To produce a large, vigorous litter, the sow must be strong and full of vitality at the time of service.

In feeding the breeding sow during the period of gestation, the feeder should aim to keep her in good, strong condition, without having her become extremely fat. Many go to the other extreme, and keep their sows thin; and the thin sow either will not do justice to her pigs, or will become a mere wreck herself during the time she is nursing her litter—in fact, the chances are that both these things will happen. A sow may be kept in pretty high condition and still produce satisfactorily, provided she takes plenty of exercise.

When on good pasture, particularly clover pasture, sows require very little meal. As a rule, however, it is well to give them a light ration of ground oats and bran or middlings. It is well to avoid the heavier and more heating kinds of grain. If used at all, they should be used very sparingly. In winter, roots should take the place of the green food; and when the sows are fed outdoors as recommended, it is best to feed the meal dry. They will require little water outside of that supplied by the roots, during cold weather. In cold weather, a little corn, wheat, or rye may be added to the oats and bran ration when the sows are fed outside, as they can stand rather more heating food under these conditions. It is, perhaps, just as well to omit barley from the ration of a breeding sow.

When the sow goes into the warm farrowing pen, it is advisable to feed the meal in the form of a thick slop, and a moderate ration of roots should be continued. This system tends to prevent constipation, and a more or less fevered condition, which may result from changing from outdoor life to confinement. After she farrows, there should be no hurry about feeding her. If she lies quiet for ten or twelve hours, so much the better. At first, she should have little more than a drink. A very thin slop of bran and middlings, given in small quantities, will answer very well. The food may be gradually increased, and in the course of a week or ten days she will be on full feed. A good mother with a large litter requires very liberal feeding. If the litter is small, it may be necessary to reduce the quantity of food.

Many different rations are used for nursing sows. A very good ration can be made by mixing two parts of finely ground oats with one part of bran and one part of wheat middlings, and allowing the food to soak between feeds. A few roots should also be fed. Sweet skim-milk is good. Some feed

a small quantity of oil cake, and no doubt it is beneficial in the mixture. The heavier grains should be fed very sparingly, if at all; and barley shou.. be omitted, as it is not a good milk former.

After the pigs are weaned, the food should be cut down to check the secretion of milk. Dry oats are a safe food for a few days after the pigs are taken away. If the udder gets very full, it is a good plan to turn the sow in with the pigs once a day for a few days.

Feeding and Management of Young Pigs.

When the little pigs are born, the attendant should be on hand and see that they are placed on their mother to suck as soon as possible. Some prefer to put the pigs in a box or basket, for the first day or two, taking them out at short intervals to suck. If the pigs are strong, however, and the sow is a reasonably good mother, it is better to leave them with her.

By the time the pigs are three weeks old, they will have learned to eat. If at all possible, they should be given access to another pen, in which is kept a small trough. Here they can be fed a little skim-milk, with a very little middlings stirred into it. The quantity of middlings can be gradually increased as the pigs grow older. If they can be taught to nibble at roots during this time, all the better. A little whole wheat, or soaked corn, scattered on the floor of the feeding pen, will cause them to take exercise while hunting for it. Exercise is very important for young pigs; and every possible means of securing it, should be adopted. If they are kept in a small pen with the mother, some of the best of them are apt to become too fat, and are likely to sicken and die. Pigs that come in the spring, however, or early fall, are more easily managed than winter litters, as they can be given outdoor exercise. If the sow is turned out with her pigs, it is not well to give her a large range, as she is likely to travel too far and tire the pigs too much.

The pigs may be weaned at six weeks old. If skim-milk is not available, it is generally better to defer weaning until eight weeks old. If they have been taught to eat as described, they will go right on eating and suffer but little from weaning. Skim-milk and middlings make about the best food for young pigs at this time. The middlings should be soaked a few hours before feeding, or, better still, scalded. If fed freshly mixed, they are likely to cause indigestion. A few finely ground oats with the hulls sifted out, make a good combination with middlings. When the pigs are first weaned, it is better to feed four times a day, feeding only what they will eat up clean before leaving the trough. When well started, they may be changed to three feeds a day.

When the pigs are three months old, a little ground barley may be added to the meal mixture. At first, the barley should constitute not more than a fifth of the total ration; and it can be gradually increased as desired, or other foods added as indicated under notes on foodstuffs.

It is important to teach young pigs to eat a few roots as early as possible; or, if it is too late in the spring for roots, some form of green food should be supplied every day.

PART V.—MISCELLANEOUS.

Cooking Food for Swine. A great many experiments have been conducted with cooked food for swine at the various experiment stations; and for this reason we have done practically nothing in this line of work, with the exception of cooking turnips. Taking the results of tests from different stations, we find many contradictory results, sometimes the cooked food scoring an advantage, but oftener, the uncooked taking the lead. So far as can be made out from the results, it would seem that cooking does not increase the feeding value of meal; and the weight of evidence is in favor of the theory that cooking decreases the digestibility of meal. Potatoes, however, appear to be improved by cooking. Turnips are rendered more palatable by cooking; but it is doubtful whether their feeding value is increased thereby. If it is desired to feed a large quantity of turnips, no doubt cooking is an advantage. In the case of sugar beets and mangels, which the hogs eat readily in the raw state, it is very doubtful whether cooking pays. On the whole, therefore, cooking apparently tends to make foods more palatable in some cases; but its effect upon the digestibility of foods appears to be injurious, rather than beneficial. Potatoes, however, seem to be an exception to the general rule, and are believed to be more digestible, as well as more palatable, when cooked.

Soaked, Wet and Dry Meal. So far as can be gleaned from experiments to date, soaking meal for several hours before feeding appears to improve its feeding value. It is doubtful, however, whether wetting the food just before feeding has very much influence. One of the difficulties we have experienced in feeding dry meal, is the prevention of waste, particularly in outside feeding, where a rather large number of hogs are fed together. In such cases, considerable meal is thrown out of the troughs and trampled into the earth. Where only a few hogs are fed together, especially where they are fed in a pen with a cement floor, there is very little waste. Where the meal is fed wet, there is danger of forcing a hog to take more water than it requires, especially in cold weather. This is most important in the case of breeding sows, especially where they are fed outdoors, as recommended elsewhere. For breeding sows fed outdoors, we would recommend dry meal. There may be a waste of meal, but we believe this will be more than paid back when the pigs are born. The whole matter, after all, is largely one of judgment, and calls for careful study of the conditions under which the feeding is done. For ordinary winter feeding, we have had very satisfactory results from mixing the dry meal with pulped roots, and allowing the mixture to stand from one feeding time to another. Both roots and meal seem to be made more palatable in this way. In warm weather, there is much less danger of supplying more water than is required.

Relation of Live Weight to Economy of Gain. In various experiments it has been shown that the amount of meal required for a pound of gain in weight steadily increases as the pig becomes heavier. Our experiments with pure-bred swine bring out this point very clearly, as the following statement shows:

Live weight of hogs. lbs.	Meal required for 100 lbs. increase in weight. lbs.
54 to 82	310
82 to 115	375
115 to 148	438
148 to 170	455

Prof. W. A. Henry, in his book "Feeds and Feeding," gives a very interesting table under this head, which he compiled from the results of many experi

ment stations. This table indicates that hogs weighing from 150 to 200 pounds require 482 pounds meal for 100 pounds gain; from 200 to 250 pounds, 498 pounds meal; and from 250 to 300 pounds, 511 pounds meal. It will be seen from these figures that the weight at which the Canadian packer wants the hog, is just about the limit of profitable feeding.

Correctives. Swine appears to have a craving for what might be called unnatural substances. This is especially true of hogs that are kept in confinement, which will eat greedily such substances as charcoal, ashes, mortar, soft coal, rotten wood, etc. It is probable that some of these substances are not good for hogs; but there is no doubt that charcoal and wood ashes have a beneficial effect, the former being greatly relished. It is good practice to supply charcoal, especially during the winter months. Wood ashes, or a mixture of wood ashes and salt, may be used in place of charcoal; but charcoal is preferable. Sods make a very fair substitute for charcoal. A waggon load or two of sods placed conveniently near the piggery, so that the feeder can throw one or two into each pen occasionally, will be found well worth the labor involved. Pigs that are outdoors in summer, and have access to earth and vegetable matter, have little need of other correctives. The term "correctives" is used for want of a better; but such substances as those described, appear to correct, or to prevent, derangement of the digestive organs.

The Feeder. To make a successful feeder, a man must have a love for the animals under his charge, and be willing to sacrifice his own comfort and convenience to theirs. He must possess sound judgment, and must make a study of the animals under his care, so that he will be able to detect the first signs of anything wrong. He must have a knowledge of the foods suited to different ages, sexes, and conditions, and his judgment will be shown in using these foods to secure the best results. In spite of all directions which may be given, emergencies are always arising to test the judgment and resourcefulness of the feeder. The suggestions, therfore, which have been offered in this bulletin, are intended as a general guide, but they cannot supply the place of skill and judgment on the part of the feeder.